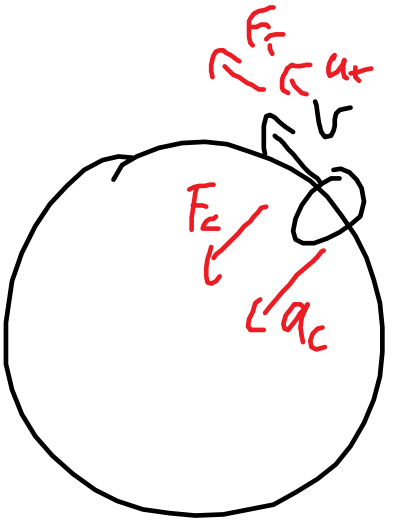
Test Next chap

CM + Grav.

Uniform

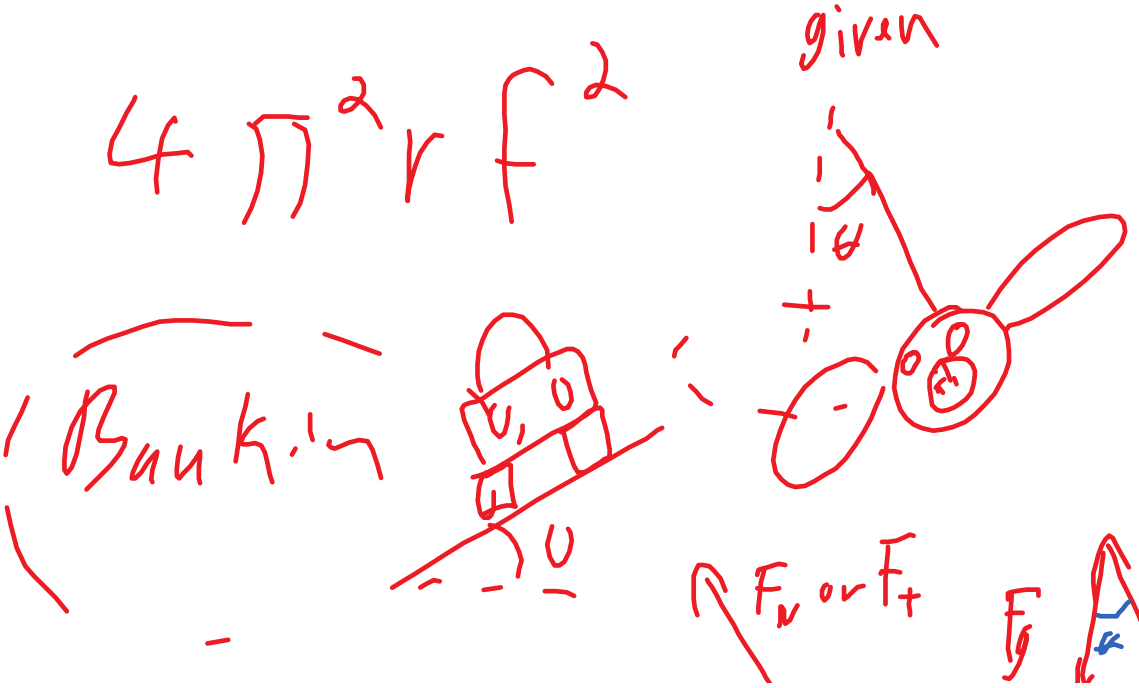


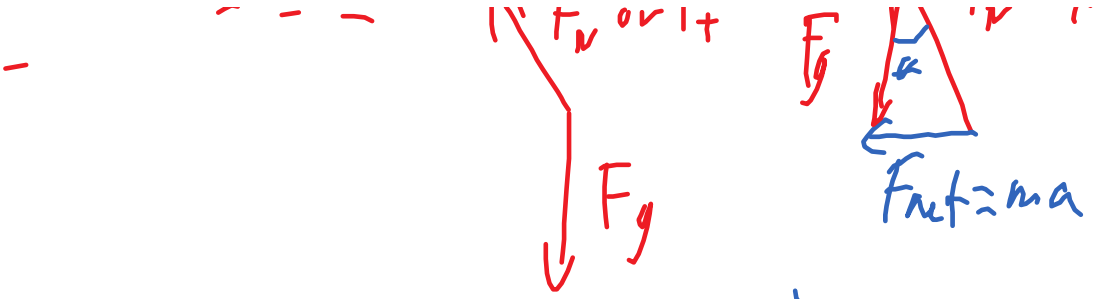
Non uniform

$$F_c = m a_c = \frac{m v^2}{r} = \frac{m 4\pi^2 r}{T^2} = m 4\pi^2 r f^2$$

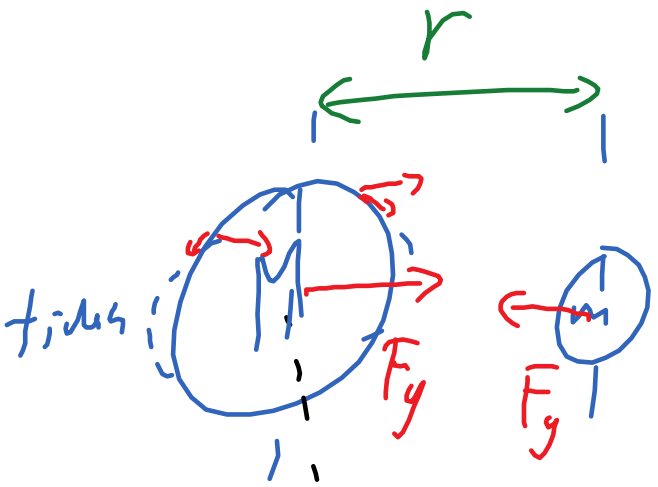
$4\pi^2 r f^2$

given





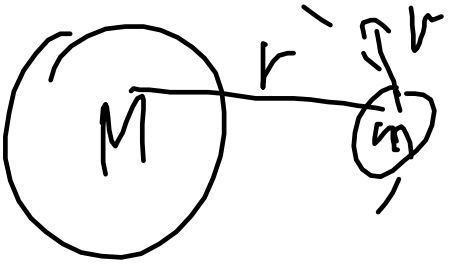
$$\tan\theta = \frac{mg}{mg}$$



$$F_g = \frac{GMm}{r^2} = mg$$

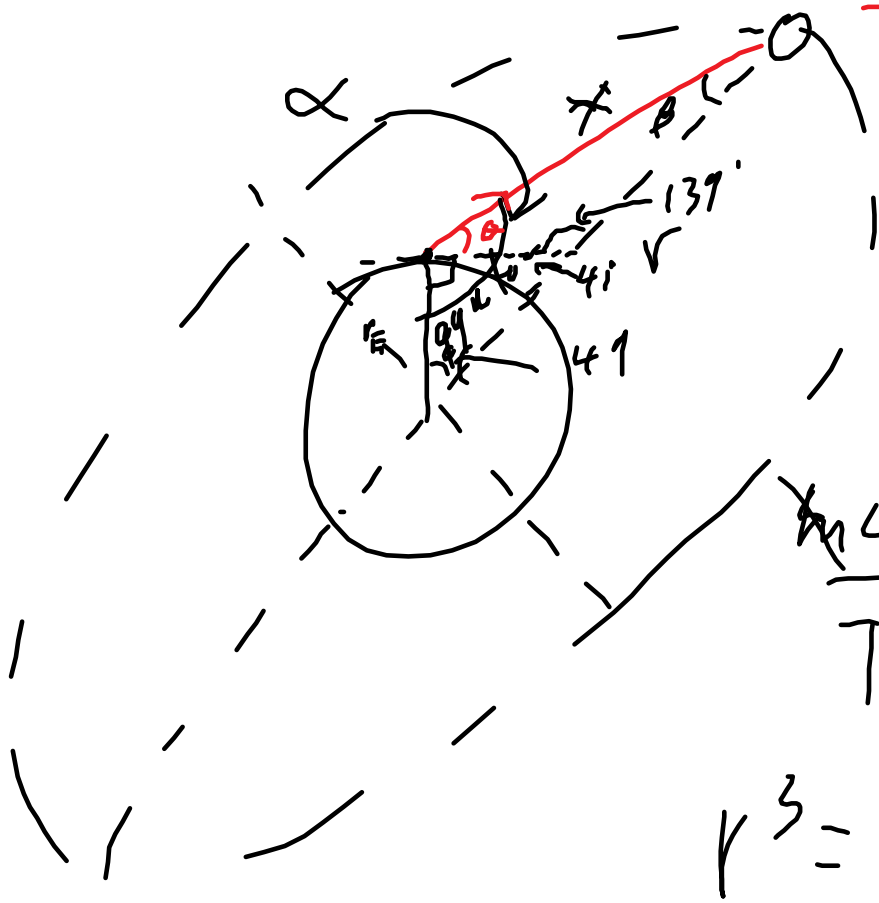
$$g \text{ at } p \text{ is } g = \frac{GM}{r^2}$$

orbits



$$F_c = F_g$$

$$\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m(2\pi)^2 r}{T^2}$$



$$F_C = F_G$$

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$\frac{4\pi^2 r}{T^2} = \frac{GM}{r^2}$$

$$r^3 = \frac{GM}{4\pi^2} T^2$$

$$r = \sqrt[3]{\frac{6.67\times10^{-11} \times 5.98\times10^{24}}{4\pi^2}\left(24\times3600s\right)^2}$$

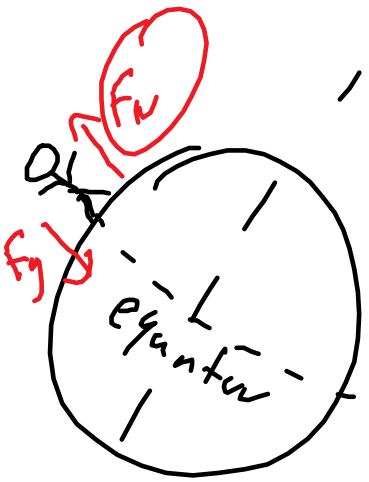
$$r = 4.22\times10^7 m$$

$$\frac{\sin\phi}{x} = \frac{\sin\alpha}{r} = \frac{\sin\beta}{r_E}$$

p 123

n = apparent weight

Q54



$$F_{net} = ma = F_g - F_N$$

$$F_N = F_g - ma$$

$$F_N = F_g - m\frac{4\pi^2 r}{T^2}$$

$$F_N = m\left(9.8 - \frac{(4\pi)^2 \times 6.38\times10^6\ m}{(24\times3600\ s)^2}\right)$$

$$F_N = m(9.7663)$$

$$a = 0.0337\ m/s^2$$

$$\frac{a}{g} = \frac{0.0337}{9.80} = \boxed{0.3\%}$$

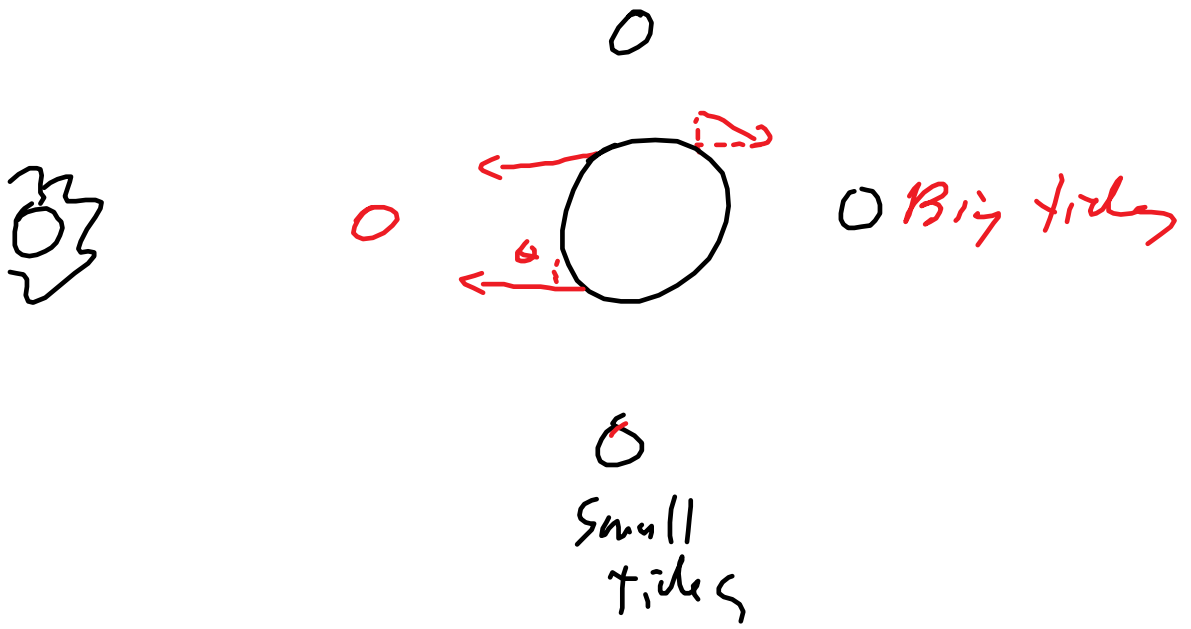
$$g = \frac{GM}{r^2} = \frac{6.67\times10^{-11}(1.98\times10^{30})}{(1.5\times10^{11}\ m)^2}$$

$$g = 5.9\times10^{-3}\ m/s^2$$

$$g_{\text{moon on Earth}} = \frac{GM}{r^2}$$

$$\frac{6.67\times10^{-11}\left(7.35\times10^{22}\,kg\right)}{\left(3.84\times10^{6}m\right)^2}$$

$$g = 3.33\times10^{-5}\,m/s^2$$



$$F_c = F_G$$

$$\frac{m 4\pi^2 r}{T^2} = \frac{G M_S m}{r^2}$$

$$M_S = \frac{4\pi^2 r^3}{G T^2}$$

$$M_S = \frac{4\pi^2 (1.5 \times 10^{11}\,m)^3}{6.67 \times 10^{-11} \left(1\,year \times 365 \times 24 \times 3600\right)^2}$$

$$M_S \approx 2.01 \times 10^{30}\,kg$$

Q51 $$g = \frac{GM}{r^2} = \frac{GM}{(\sqrt{2}\,r)^2}$$

$$\frac{1}{2} g_E = \frac{GM}{r^2} = \frac{1}{\alpha} \frac{GM}{r_E^2}$$

$$r^2 = 2r_E^2$$

$$r = \sqrt{2}\, r_E$$

last Question Quiz

$$\frac{GM_p}{r_1^2} = \frac{GM_m}{r_2^2} \qquad r_1 + r_2 = d$$

$$\frac{M_p}{M_m} = \frac{r_1^3}{r_2^3}$$

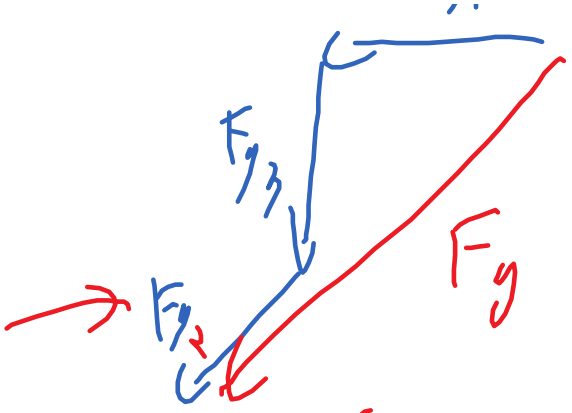
$$\sqrt{\frac{M_p}{M_m}} = \frac{d - r_2}{r_2}$$

p 122
Q 31

$$r_2 = \sqrt{0.5^2 + 0.5^2}$$

$$F_{g1} = \frac{GMm}{r^2} = \frac{6.67\times10^{-11}(8)(8)}{(0.5)^2}$$

$$= 1.70175\times10^{-8}\,N$$



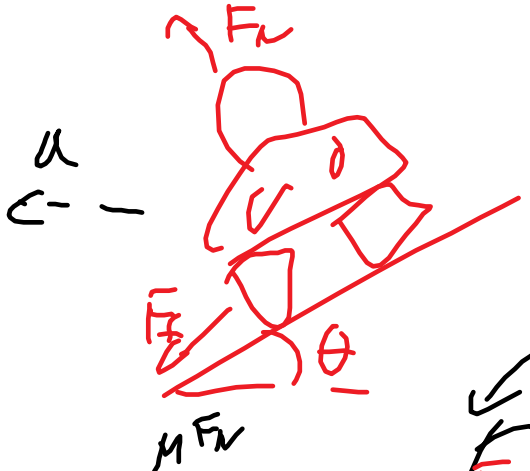
$= 1.7075 \times 10^{-6} N$

$= F_{y_3}$

$$F_{y_2} = \frac{6.67 \times 10^{-11}(8)(8)}{0.5^2 + 0.5^2} = 8.54 \times 10^{-9} N$$

$$F_y = \sqrt{F_{y_1}^2 + F_{y_3}^2} + F_{y_2}$$

$$F_y = 3.3 \times 10^{-8} N$$



$\mu F_N \cos\theta + F_N \sin\theta$

$F_N(\mu - \tan\theta)\cos\theta$

$ma = F_f \cos\theta + F_N \sin\theta$

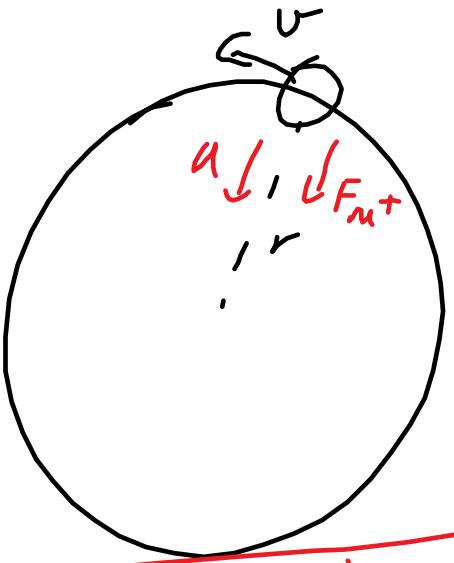
$F_N \cos\theta = mg + F_f \sin\theta$

μF_N

$F_N = mg\cos\theta$ a

Test next class

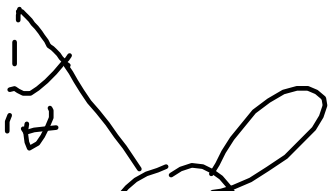
Circular motion and Gravity

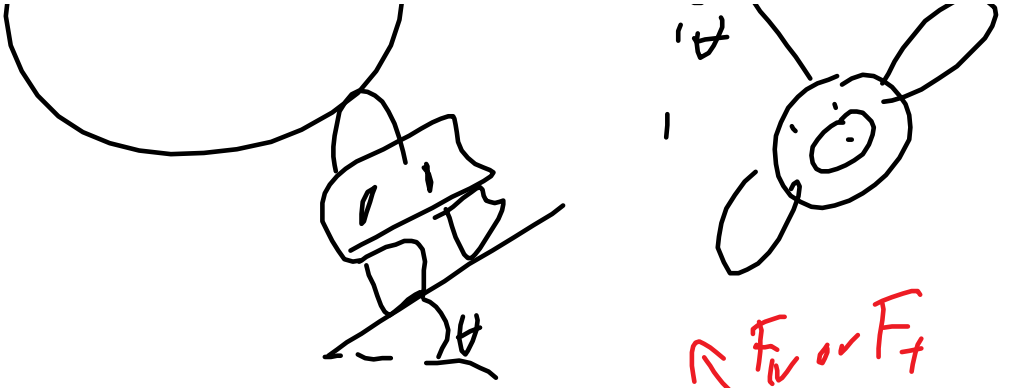


uniform

$F_{net} = ma = m\frac{4\pi^2 r}{T^2} = \frac{mv^2}{r} = m4\pi^2 r f^2$

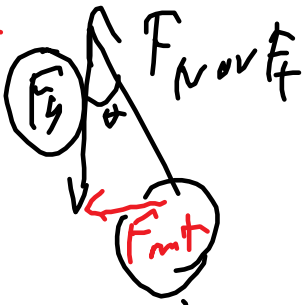
$a_c = \frac{v^2}{r} =$





F_N or F_T

F_g



$$\tan\theta = \frac{mg}{mg}$$

$$\boxed{\tan\theta = \frac{a}{g}}$$

$$\tan\theta = \frac{v^2}{rg} \text{ or } \frac{(2\pi)^2 r}{T^2 g}$$

Gravity

$$F_g = \frac{GMm}{r^2}$$

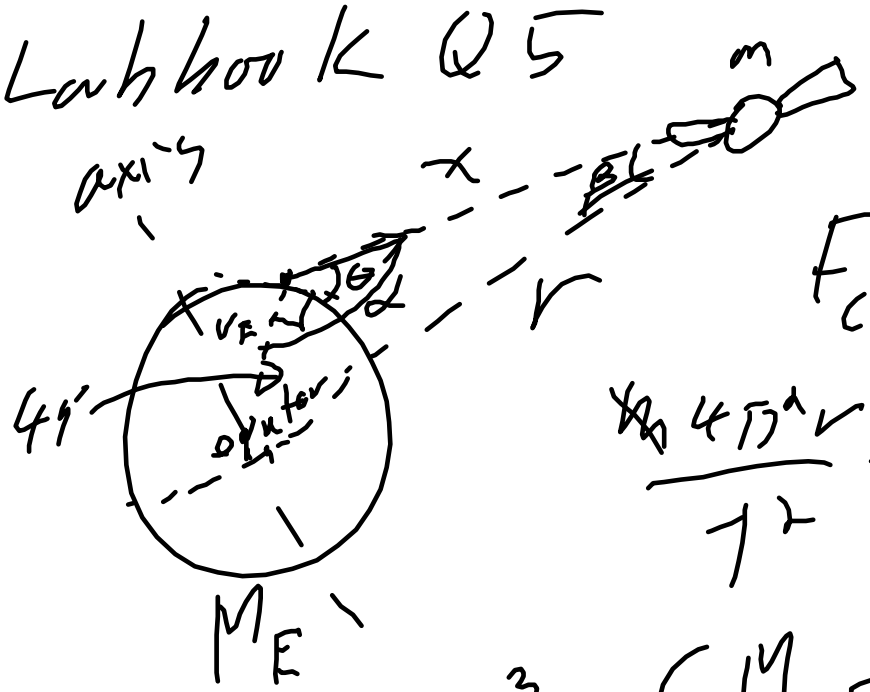
Orbit $\quad F_c = F_g$

Universal $F_C = F_g$

$$\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m4\pi^2 r}{T^2}$$

$$g = \frac{GM}{r^2}$$

Lab book Q5



Geostationary $T = 24\,hrs$

$F_C = F_g$

$$\frac{4\pi^2 r}{T^2} = \frac{GM_E}{r^2}$$

$$r^3 = \frac{GM}{4\pi^2} T^2$$

$$r = \sqrt[3]{\frac{6.67\times10^{-11} \times 5.98\times10^{24} (24\times3600s)^2}{4\pi^2}}$$

$$r = 4.22 \times 10^7\,m$$

~~$\sin\alpha = \sin\beta$~~

$\frac{\sin\alpha}{r} = \frac{\sin\beta}{r_E}$

$c^2 = a^2 + b^2 - 2ab\cos C$

$x^2 = r^2 + r_E^2 - 2rr_E\cos 49°$

$x = 3.832 \times 10^7 m$

$\frac{\sin 49°}{x} = \frac{\sin\alpha}{r}$ $\quad \alpha = 90 + \theta$

$\sin\alpha = \frac{r\sin 49°}{x}$

$\alpha = 56.2°$ or $123.8°$

-90

$\theta = 33.8°$

p123
Q54

$a = \frac{4\pi^2 r}{T^2}$

24 hrs

apparent weight

$$a = \frac{4\pi^2 (6.38\times10^6\ m)}{(24\times3600\ s)^2}$$

$$a = 0.034\ m/s^2$$

$$\text{ratio} = \frac{a}{g} = \frac{0.034}{9.8} = 0.0034$$

$$ma = F_g - F_N$$

$$F_N = F_g - ma$$

pole

r_p

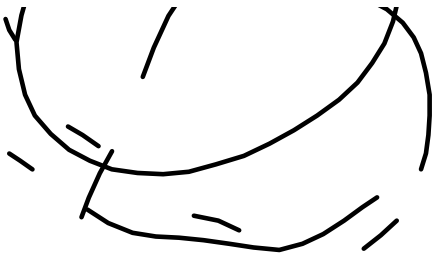
r_e

equator $F_{ge} < F_{gpole}$

P 123

Prob 61

a



$a = g$

$\frac{4\pi^2 r}{T^2} = g \qquad T^2 = \frac{4\pi^2 r}{g}$

$T = 2\pi\sqrt{\frac{6.38\times10^6\ m}{9.8\ m/s^2}}$

$T = 5064\ s$

$\boxed{T = 1.4\ hrs}$

Lab

Q2 – assume $F_c = F_g$

$\frac{M_E 4\pi^2 r}{T^2} = \frac{GM_{sun}}{r^2}$

$r^3 \quad GM_{sun}T^2$

$$r^3 = \frac{GM}{4\pi^2} T^2$$

$$r^3 = \frac{(6.67\times10^{-11})(1.98\times10^{30})}{4\pi^2}(76\times365.25\times24\times3600)^2$$

$$K = \frac{R^3}{T^2} = \frac{\frac{GM_E}{4\pi^2}}{\frac{GM_S}{4\pi^2}} \quad \frac{M_E}{M_S}$$

$$\frac{5.96\times10^{24}}{1.98\times10^{30}} =$$

$$\rho = \frac{M}{V} \qquad V = \frac{4}{3}\pi r^3$$

$$M = \rho V$$

$$g = \frac{GM}{r^2} = \frac{G\rho V}{r^2}$$

$$V = \rho\frac{4}{3}\pi r^3$$

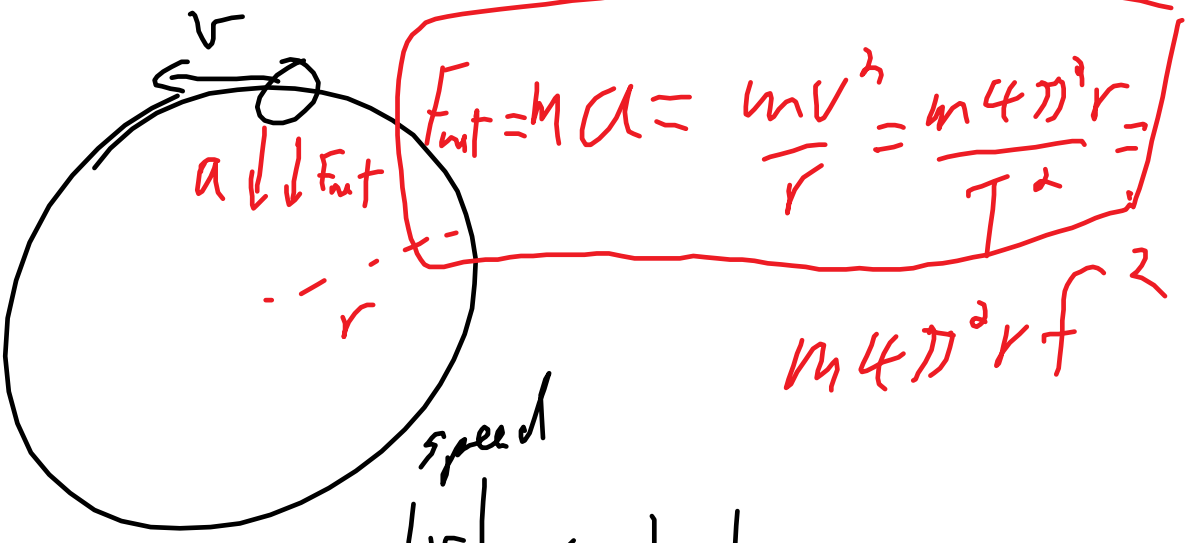
$$g = G\rho\frac{4}{3}\pi r$$

$$g = \left(\frac{4}{3}\pi G\right)\rho r$$

Block 2-2

Test Next Class

CM + Grav.



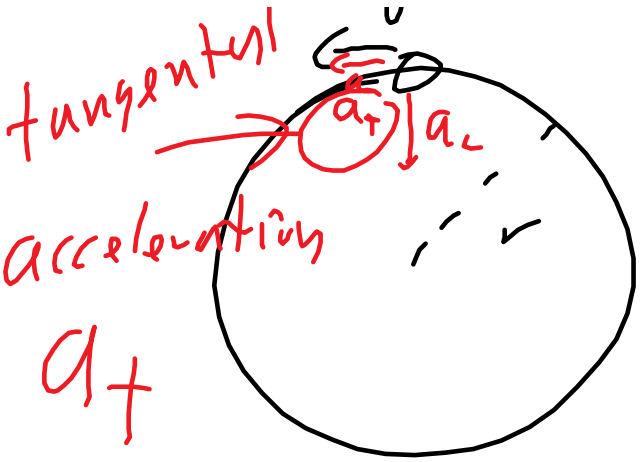
speed

$|v|$ = constant

Uniform,

tangential

Non-uniform

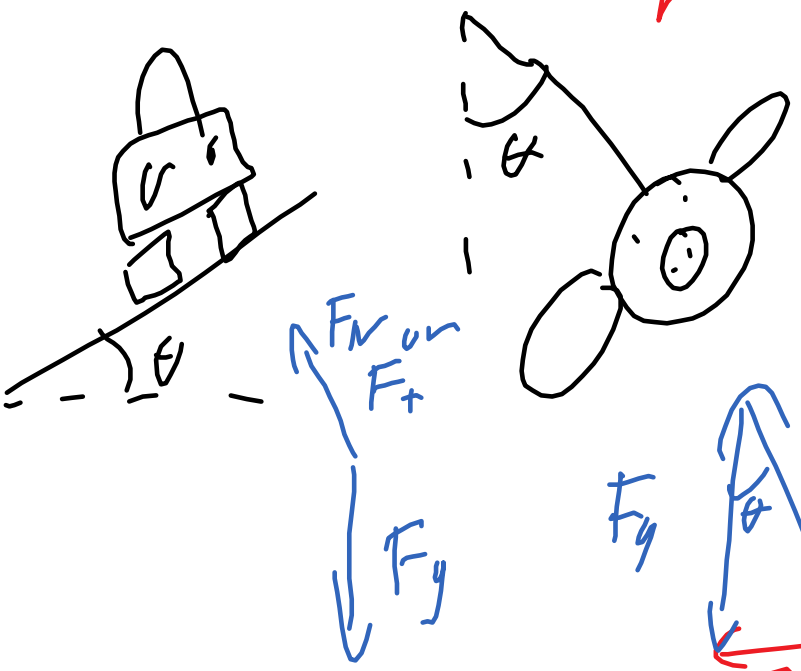


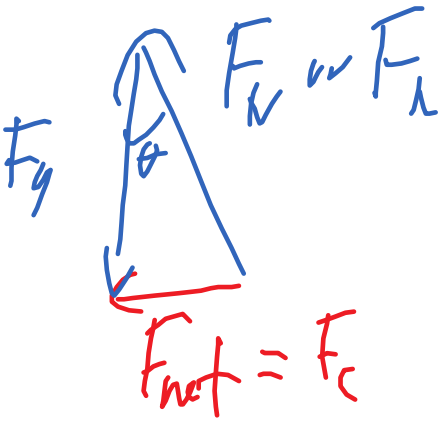
Non-uniform

$|v|$ changes

a_t

$a_c = \frac{v^2}{r}$

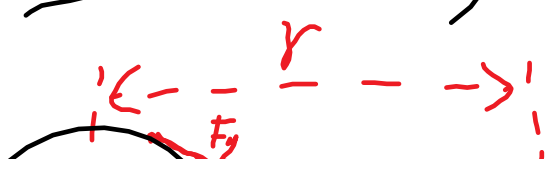




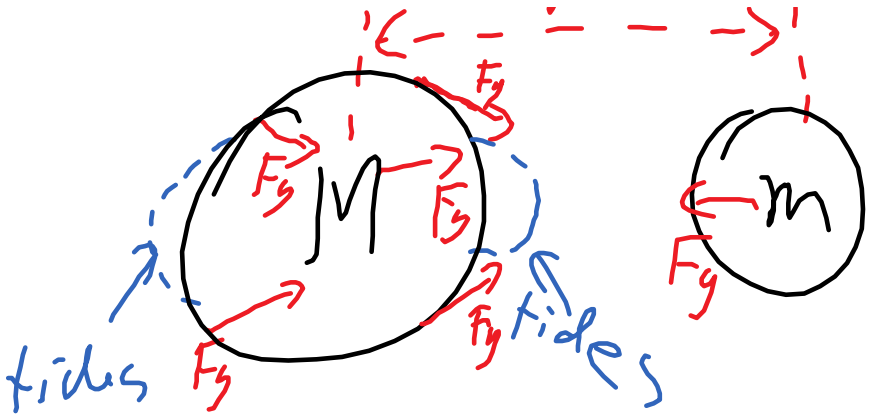
$$\tan\theta = \frac{F_{net}}{F_g} = \frac{ma}{mg}$$

$$\tan\theta = \frac{a}{g} = \frac{v^2}{rg} = \frac{4\pi^2 r}{T^2 g}$$

Gravity



$$F_g = \frac{GMm}{r^2}$$



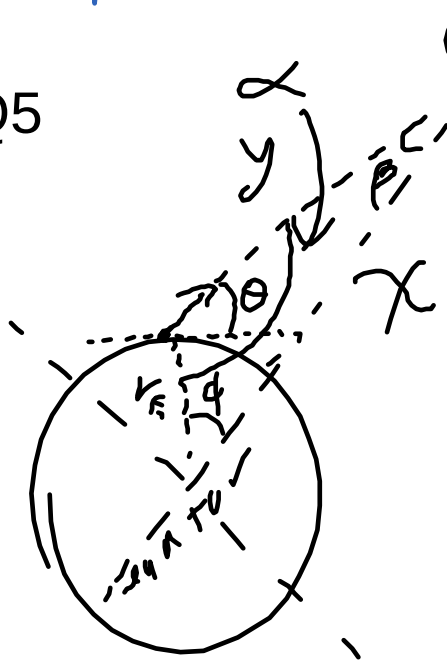
$F_g = \frac{\quad}{r^2}$

caused by sideways component of F_g

for orbits $F_c = F_g$

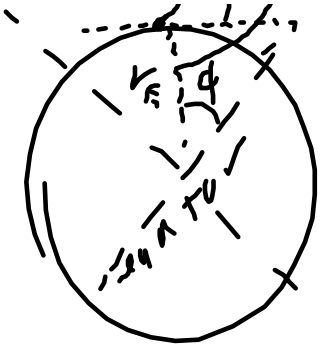
$$\frac{GMm}{r^2} = \frac{mv^2}{r} = \frac{m(4\pi)^2 r}{T^2}$$

Lab Q5



$\phi = 49°$

$F_c = F_g$



$\phi = 49°$

$F_c = F_g$

$$\frac{m 4\pi^2 r}{T^2} = \frac{GMm}{r^2}$$

$$r^3 = x^3 = \frac{GM_E}{4\pi^2} T^2$$

$$x = \sqrt[3]{\frac{6.67\times10^{-11}\ 5.98\times10^{24}}{4\pi^2}(24\times3600s)^2}$$

$$= 4.22\times10^7\ m$$

Cosine law

$$a^2 = b^2 + c^2 - 2ac\cos A$$

$$y^2 = x^2 + r_E^2 - 2x r_E \cos 49°$$

$$y = 3.8\times10^7\ m$$

Sine Law

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

$$\frac{\sin 49^\circ}{y} = \frac{\sin \alpha}{x}$$

$$\alpha = \sin^{-1}\frac{4.22\times10^7 \sin 49^\circ}{3.8\times10^7}$$

$$\alpha = 56.94^\circ$$

$$\alpha = 180 - 56.94^\circ$$

$$\alpha = 123^\circ$$

$$\theta = \alpha - 90$$

$$\theta = 123^\circ - 90 = \boxed{33^\circ}$$

Q29 p 122

$$g = \frac{GM}{r^2} \quad \left(\rho = \frac{M}{V} \quad V = \frac{4}{3}\pi r^3 \quad M = (\rho V) \right)$$

$$g = \frac{G\rho V}{r^2}$$

$$g = \frac{G\rho \frac{4}{3}\pi r^3}{r^2}$$

$$g = \frac{4}{3}\pi G \rho r$$

or $$g = \frac{GM}{r^2} \qquad \rho = \frac{M}{\frac{4}{3}\pi r^3}$$

$$r^3 = \frac{3M}{4\pi\rho}$$

$$r_2^3 = 2\left(\frac{3M_1}{4\pi\rho}\right)$$

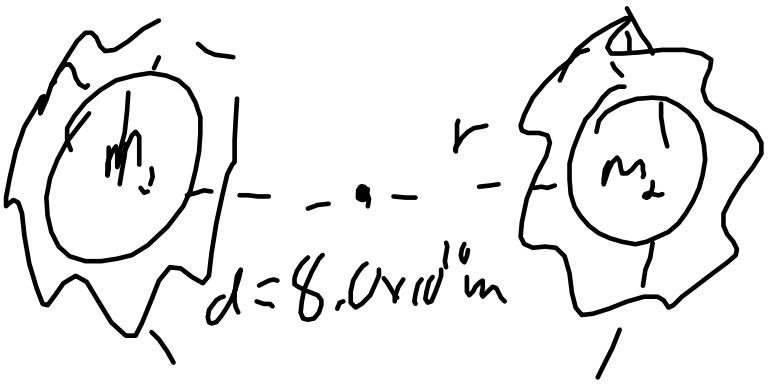
$$r_2^3 = 2r^3$$

$$g = \frac{2GM_1}{(\sqrt[3]{2}\, r_1)^2}$$

$r_2 = \sqrt[3]{2}\, r_1$

$$g_2 = \frac{2}{(\sqrt[3]{2})^2}\, g_1$$

$$g_2 = 126\, g_1$$



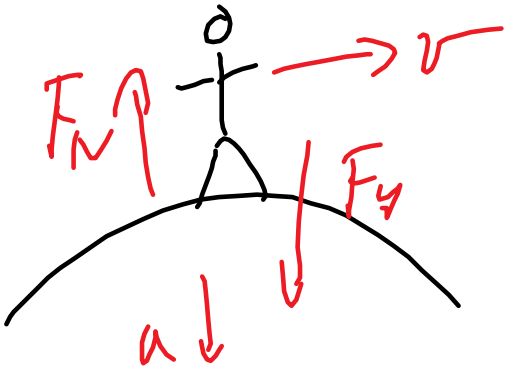
$$\frac{GMm}{d^2} = \frac{4\pi^2 r m}{T^2}$$

$$M = \frac{4\pi^2 r d^2}{G T^2}$$

$$M = \frac{4\pi^2 (4 \times 10^{10}\ \text{m})(8 \times 10^{10}\ \text{m})^2}{6.67 \times 10^{-11}\ \text{Nm}^2 (126 \times 365.25$$

$6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$ $(24 \times 3600)^2$ $\times 24 \times 3600)^2$

$M = 9.6 \times 10^{26}$ kg each



$F_g > F_N$

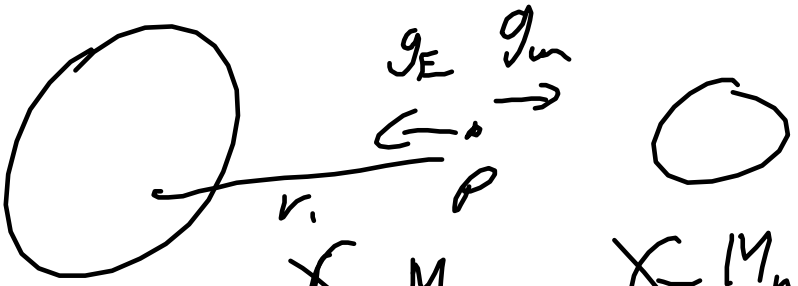
apparent weight

$a = \frac{4\pi^2 r}{T^2}$

$a = \frac{4\pi^2 (6.38 \times 10^6)}{(24 \text{hrs} \frac{3600 s}{h})^2}$

$a = 0.034 m/s^2$

$\frac{0.034}{9.8} = 0.0034$



$$\frac{M_E}{r_1^2} = \frac{M_m}{r_2^2}$$

$$\frac{M_E}{M_m} = \frac{r_1^2}{r_2^2}$$

$$\sqrt{\frac{M_E}{M_m}} = \frac{r_1}{r_2} = \frac{r_1}{d - r_1}$$

$$\sqrt{\frac{5.98 \times 10^{24}}{7.35 \times 10^{22}}} = \frac{x}{3.84 \times 10^8 - x}$$

$$9.02 = \frac{x}{3.84 \times 10^8 - x}$$

$3.464 \times 10^8 - 9.12x = x$

$x = 346 \times 10^8 m$